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ELECTRONIC DEVICE

This invention relates to an electronic device having an enclosure for electronic circuits for the suppression of spurious unwanted emissions such as harmonic emissions from electronic circuit components and discontinuities and, more particularly, to enclosures for suppressing or substantially reducing the emission of unwanted electromagnetic radiation whilst concurrently allowing the emission of wanted electromagnetic radiation.

Electronic circuits, and in particular microwave circuits, are used in a variety of applications, for example, they are commonly employed in motion detection units for detecting a moving person or object by means of a Doppler frequency shift. A motion detector is arranged to emit electromagnetic radiation at particular frequencies via a given aperture, that is to say, a motion detector is an intentional radiator of electromagnetic radiation.

All electronic circuits generate and radiate spurious emissions which can exceed a maximum level set by current EMC regulations. In order to conform to current EMC standards, any spurious emissions from circuit components and discontinuities having frequencies which fall outside an allocated frequency band must be

suppressed. Circuit elements or devices, for example, dielectric resonator oscillators and mixers, which are typically used in motion detection units, can generate significant levels of harmonic emissions. These emissions can leak out through the mechanical joints between, for example, the enclosure and the circuit board of the microwave motion detection unit.

DE-3 515 910 discloses an enclosure for a high frequency electronic circuit. The electronic circuit has an extension to which an external connection can be made. The enclosure comprises a chamber which accommodates the extension for suppressing electromagnetic emissions therefrom.

Circuits are therefore often housed in enclosures which act as shields to prevent unwanted emissions radiating into free space.

These enclosures are usually made of a conducting material such as aluminium or brass, or metal coated plastic. A conducting mesh can also be used providing that the apertures in the mesh are small enough to prevent the emissions from escaping. Enclosures can also be made of an absorbing material to absorb the emissions. Alternatively, a plastic material loaded with metal filings or granules can be used to confine emissions to the enclosure.

High frequency emissions are more difficult to screen because they can escape through small gaps in the enclosure, for example, where the cover and the main enclosure joins, or at cable entry points.

Figure 1 shows a perspective view of a known motion detector 1. A frame 5 is used to clamp a printed circuit board 2 to the main enclosure 6. The circuit side of the printed circuit board faces inwards into the enclosure. The conducting groundplane of the printed circuit board is outward facing. A printed antenna is attached to the groundplane and is coupled to the circuit via a slot in the groundplane. Printed circuit board 2 has a solder tab 3. In order to accommodate solder tab 3, a slot is cut into a side wall of frame 5 in order to allow the tab to pass through. A ribbon cable 9 is soldered to tab 3.

The gap between the circuit board 2 and one side of the slot in frame 5 is sealed by means of gasket 7 to block emissions. The gap between the circuit board and the other side of the slot has been minimised, but some clearance, gap 8, is necessary to prevent lines or components on the printed circuit board from being short circuited by either frame 5 or main enclosure 6. Gap 8 provides a path for unwanted emissions to radiate into free space.

In the present invention, an improved method of suppressing unwanted radiated emissions, such as microwave or RF emissions, from an electronic circuit such as a microwave circuit and/or antenna circuit is provided wherein:

In a preferred embodiment, the first and second portions are adapted to provide a chamber about the connection means.

Preferably, the second frame portion comprises an extension sized and shaped to substantially surround the upstanding connection means. Preferably, the extension is sized and shaped to clear the upstanding connection means. The extension may comprise an outwardly extending recess in a peripheral wall of the second frame portion. Preferably, the peripheral wall of the frame, including the recess, is continuous, that is, the peripheral wall and the recess are formed in an integral manner. The frame may comprise electromagnetic radiation absorbing and/or reflecting material. Preferably, the frame is conducting.

In a further preferred embodiment, the first main portion comprises a projection extending from a wall of the main portion. Preferably, the projection on the first main portion and the extension on the second frame portion are sized and shaped to form an electromagnetically sealed chamber about the extending connection means.

Preferably, the projection of the first main portion comprises one or more apertures through which a connection to the connection means can be made.

Preferably, the aperture is sized and shaped to accommodate a cable, antenna feed, power source or the like. The cable may be a ribbon cable. The connection means may be adapted for connection to the cable, antenna, power source or the like. The connection means may be a solder tab.

Preferably, the first main portion comprises electromagnetic radiation absorbing and/or reflecting material. Preferably, the first main portion is conducting.

Preferably, the enclosure for the microwave circuit board is conductive and can be constructed in metal, such as brass or aluminium, or be of a metal coated plastic. The enclosure could comprise a microwave absorbing material. A plastic material loaded with metal filings or granules could be used.

The enclosure can comprise an injection moulded cover, for example, of a metal loaded plastics material, the cover having an edge region conforming substantially to the edge of the microwave circuit board and being a close fit therewith. Any gaps between the peripheral edge of the microwave circuit board and the peripheral edge of the enclosure are minimised.

Microwave circuit components capable of radiating unwanted emissions include, for example, dielectric resonator oscillators, mixers and like components. Discontinuities in the printed or etched microwave circuit components, such as microstrip lines, can also give rise to unwanted emissions.

In a further preferred embodiment, the circuit board is a printed circuit board.

In a further preferred embodiment, the device is a microwave circuit device, preferably, an intrusion detection device, for example, a motion detection device.

A preferred embodiment of the invention will be described now, by way of example only, with reference to the following figures.

Figure 2 illustrates a perspective view of a frame for an electronic circuit device having an extension, seen from above.

Figure 3 illustrates the frame of figure 2, seen from below.

Figure 4 illustrates a perspective view of printed circuit boards, seen from above.

an enclosure for the circuit having a chamber for suppressing various emissions is provided about connection means extending from a circuit board, for example, a solder tab; and/or

an enclosure for the circuit is provided having an aperture sized and shaped to be a close fit about an item to be connected to the circuit board such as a cable.

In a first aspect, therefore, the present invention provides an electronic device comprising an enclosure for a circuit board bearing elements, for example, components and/or discontinuities, capable of radiating unwanted emissions, the circuit having at least one connection means extending from a surface or a periphery of the board to which an external connection is to be made, the enclosure comprising only a first main portion and a second frame portion, the board being mounted there between, preferably, with an outwardly facing circuit groundplane outward facing;

at least one of either of the first or second portions comprising means for substantially surrounding the extending connection means;

whereby unwanted emissions generated by the electronic circuit are substantially prevented from leaving the enclosure via a region adjacent to the connection means.

Figure 5 illustrates a perspective view of a main enclosure for an electronic circuit, seen from above.

Figure 6 illustrates a perspective view of an electronic circuit, in this case a motion detector assembly, when fully assembled, seen from below.

Referring to figure 2, there is shown a frame 10 or first portion of an enclosure made of a electrically conductive material and having a continuous or integrally formed outer wall 10a. The enclosure is arranged to accommodate a circuit board bearing elements capable of generating undesired electromagnetic radiation. The outer wall 10a comprises an extension 11 for housing a circuit element which extends from said circuit board.

Referring now to figure 3, there is shown schematically a perspective view of the first portion view from below. It can be seen that extension 11 comprises a recess 12 in order to accommodate an extending connection means, for example, solder tabs or the like (not shown).

Figure 4 depicts a printed circuit board assembly 2 comprising a microwave circuit board 2c and having connection means in the form of a solder tab 8 extending outwardly from the periphery of the microwave circuit board 2c. An antenna circuit board 2a having an antenna

printed thereon is also provided. The antenna circuit board and the microwave circuit board face in mutually opposite directions. When the printed circuit board assembly is mounted within the enclosure, the microwave circuit board 2c is inwardly directed whereas the antenna circuit board 2a is outwardly directed. The printed antenna is mounted on the back of printed circuit board 2c. A groundplane is disposed between the microwave circuit board 2c and the antenna circuit board 2a.

A solder tab 8 is provided to allow external connections to the microwave circuit board 2c, antenna circuit board 2a and the ground plane 2b, such external connection being used for the provision of signal cables, power cables and earth connection. The recess 12 in outer wall 10a of frame 10 is sized and shaped to substantially surround tab 8 without, in this preferred embodiment, coming into contact therewith. The lack of contact between the wall of the recess 12 and the solder tabs avoids short circuits between any circuit elements associated with or carried by the extending connection means. The outer wall 10a is continuous ie no slots, or other gaps, are provided in the frame wall which could result in unwanted leakage of emissions. Preferably, the outer wall is integrally formed by, for example, injection moulding.

With reference to figure 5, a main or second part 13 of the enclosure is shown. Printed circuit board assembly 2 is mountable within the space 14 of the enclosure 13.

An outwardly extending projection 15 is provided in the wall of the second part of the enclosure 13 at a location corresponding to the location of solder tab 8 on circuit board 2. Projection 15 comprises at least one aperture 16 arranged to snugly receive the cables for the external connections to the solder tab 8. Typically, the external connections are provided by using a ribbon cable. When assembled, solder tab 8 is positioned adjacent upper surface 17 of projection 15.

Referring now to figure 6 there is shown an assembled electronic device, for example, a motion detector, comprising the frame 10 and main enclosure portion 13. The printed circuit board assembly 2 is housed within the chamber formed by the frame and the assembly. The frame 10, main enclosure portion 13 and printed circuit board 2 have been aligned prior to assembly so that projection 15, extension 11 and solder tab 8 are all substantially aligned to thereby prevent the emission of unwanted radiation. As can be seen from figure 6, projection 15 snugly cooperates with the open aspect of recess 12 to so to form an electromagnetically sealed extension chamber within which solder tab 8 is

located to prevent emission of em-radiation from within the chamber. The only access to solder tab 8 is via aperture 16 through which a ribbon cable, for example, can be located. The cable is a close, push fit within the spaced circular holes which form aperture 16. The holes can be cylindrical or tapered to ease insertion of the cable.

The printed circuit board 2 with groundplane facing outwards, is mounted in the main enclosure 13 and held in place by frame 10. The frame and the main enclosure in the vicinity of the solder tab, ie projection 15 and extension 11, are a close fit to substantially obviate or reduce emissions escaping through the joint. The solder tab is now completely enclosed in a chamber formed by the frame and the main enclosure.

Although there is still a path through the cable insulation, ie the outer part of the ribbon cable, by which emissions can escape, the actual gap between the cable conductor, ie the central part of the cable, and the enclosure is as a consequence of the sung fit smaller and hence unwanted emissions are significantly reduced.

It will be apparent to those skilled in the art from the information contained herein that the principle of shaping the aperture in the wall of an enclosure to minimise gaps through which cables pass, can be applied

to cables with different cross sections or to items other than cables, such as components, antennas feeds and the like.

It will also be apparent to those skilled in the art that the preferred assembly is one in which the printed circuit board assembly is mounted within the enclosure with the component side facing inwards. The printed circuit board assembly is held in place by a frame. The outer surface of the printed circuit comprises a groundplane so that the component side of the circuit is completely surrounded and emissions are confined to the enclosure. A printed antenna is attached to the back of the groundplane and coupling between circuits is achieved via a slot in the groundplane.

However, the invention can be applied to other mechanical arrangements. For example, the printed circuit board can be completely encased within a chamber consisting of a main enclosure and a separate cover. The assembly would not then be reliant on the circuit groundplane to act as a screen. Access to the circuit would be by a method similar to that used with the frame.

Indeed, the principle of providing an enclosure having a chamber, for absorbing, reflecting and/or otherwise suppressing emissions, about a connection means extending from a circuit board and/or providing an

aperture sized and shaped to be a close fit about an item to be connected to the circuit board can be applied to other mechanical arrangements. All such alternative embodiments are intended to be within the scope of this application.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.